

1. INTRODUCTION

1.1 Bioassessment and Biocriteria in Water Resource Assessment and Management

The Historical Context

During the last half of the 20th century, the terms “environmental protection” and “natural resource management” underwent a profound evolution both conceptually and as applied to decision-making. Two landmark pieces of legislation, the 1948 Federal Water Pollution Control Act (WPCA) and its 1972 amendments contained in the Clean Water Act (CWA), stand out as milestones in this process. Until 1948, water quality management decisions were based primarily on society’s economic and public health priorities (Davis 1995). The passage of the 1948 WPCA marked the first time that the *propagation of fish and other aquatic life* was articulated as a stand-alone objective of water resource protection. It was a significant turning point because federal law recognized the importance of protecting waterbodies and aquatic life for their own intrinsic value, not just for their value to human society.

The 1972 Federal Water Pollution Control Act (the Clean Water Act) set far-reaching ideals for restoring the health of our Nation’s waters, as outlined in Section 101(a) Declaration of Goals and Policy:

The objective of this Act is to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters. In order to achieve this objective it is hereby declared that, consistent with the provisions of this Act –

- 1) it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985;
- 2) it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish and wildlife and provides for the recreation in and on the water be achieved by July 1, 1983...

Why Bioassessment?

Aquatic life (fish, insects, plants, shellfish, frogs, salamanders, etc.) integrate the cumulative effects of both point source and nonpoint source (NPS) pollution’s multiple stressors. Biological assessments, or bioassessments, consisting of surveys and other direct measures of aquatic life, are the most effective way to measure the aggregate impact of these stressors on waterbodies. Bioassessments are an extremely useful tool to evaluate the biological integrity of a waterbody, commonly defined as

“the ability to support and maintain a balanced, integrated, and adaptive community with a biological diversity, composition, and functional organization comparable to those of natural aquatic ecosystems in the region” (Frey 1977, Karr and Dudley 1981, and Karr et al. 1986).

Because biological communities are affected by all of the environmental factors to which they are exposed over time, bioassessments provide information on perturbations not always revealed by water chemistry measurements or toxicity tests. Thus, they are crucial for determining not only biological health but the *overall* health, or ecological integrity, of a waterbody.

In the mid-1980s, a national workgroup of EPA regional and state agency biologists was convened to provide oversight in the development of technical guidance for biological assessment. The result of the workgroup was the 1989 publication of EPA’s Rapid Bioassessment Protocols (RBPs) (USEPA 1989). The RBPs provide a technical framework for using biological assemblage data as a direct indicator of ecological health. The RBPs synthesized existing methods for monitoring fish and benthic macroinvertebrates in streams and wadeable rivers, and presented some innovative ways to assess the biological and physical aspects of streams. The RBP methods were designed to be cost effective,

reliable, efficient, applicable nationwide, and easily understood by various stakeholders (USEPA 1999). In addition, the 1990 publication of *Biological Criteria: National Program Guidance for Surface Waters* provided states with an organized approach for addressing their responsibilities as outlined in the CWA (USEPA 1990). In 1992, EPA issued procedures for initiating narrative biological criteria that explained how states and tribes could adopt narrative biocriteria in their water quality standards (USEPA 1992).

Since the 1989 RBPs were published, the use of bioassessments in water resource programs has continued to grow. In 1996, EPA published a guidance document for the development of biocriteria for streams and small rivers (USEPA 1996a). In 1998, EPA produced bioassessment technical guidance for lakes and reservoirs (USEPA 1998a), followed by similar guidance for estuarine and coastal marine waters in 2000 (USEPA 2000) and a series of guidance modules for biological assessments and index development for wetlands in March 2002 (USEPA 2002). The increased use of bioassessment in water monitoring programs nationwide led to the 1999 revision of the original RBPs for streams and Wadeable Rivers (USEPA 1999). Guidance for large rivers and coral reefs is currently under development.

Over the last 50 years, the science of environmental protection has come a long way both in theory and in practice. As a society, the United States has come to understand that protecting aquatic life is a critical resource management goal in its own right. We have adopted ecological integrity as a barometer of waterbody health. Resource management agencies at the local, state, tribal, and national levels have recognized the importance of biological assessments in the evaluation of water quality and ecological integrity. This evolution has brought us closer to realizing the CWA's goal of restoring and maintaining the physical, chemical, and biological integrity of the Nation's waters.

Current Legal Authority

The CWA and its amendments through 1987 provide the legal authority for the use of biological assessments and criteria in state and tribal water quality programs primarily under the provisions of sections 303 and 304. Under Section 303(c), states are required to have water quality standards that consist of designated uses, criteria to protect those uses, and an antidegradation policy. Also under section 303(c), states are required to review their standards every three years and revise them as needed to achieve the purposes of the Act, including the ecological integrity objective.

Section 303(c)(2)(B), enacted in 1987, requires states to adopt numeric criteria for toxic pollutants for which EPA has published 304(a)(1) criteria if such pollutants interfere with, or may be expected to interfere with, attainment of designated uses. The section further requires that, where numeric 304(a) criteria are not available, states adopt criteria based on biological assessment and monitoring methods consistent with information published by EPA under 304(a)(8).

Section 304(a)(8) directs EPA to develop and publish information on methods for establishing and measuring water quality criteria for toxic pollutants on bases other than pollutant-by-pollutant. This includes biological monitoring and assessment methods that evaluate:

the effects of pollutants on aquatic community components ("...plankton, fish, shellfish, wildlife, plant life...") and community attributes ("...biological community diversity, productivity, and stability...");

factors necessary "...to restore and maintain the chemical, physical, and biological integrity of all navigable waters..." for "...the protection of fish, shellfish, and wildlife for classes and categories of receiving waters..."

appropriate "...methods for establishing and measuring water quality criteria for toxic pollutants on other bases than pollutant-by-pollutant criteria, including biological monitoring and assessment methods."

The Uses of Bioassessment and Biocriteria in the Clean Water Act

Biocriteria, derived from bioassessment data, are narrative descriptions and numeric values that describe the desired condition for the aquatic life inhabiting waters with a designated aquatic life use. Biocriteria are an effective tool for addressing water quality problems by providing regulatory mechanisms to assess and help protect the biological resources at risk from chemical, physical, or biological impacts. These narrative and/or numeric biocriteria may be formally adopted into water quality standards along with an antidegradation policy intended to protect waters from further deterioration.

As required in the Clean Water Act, states, tribes, and territories report on the quality of their waters through a biennial report referred to as the "305(b) report". USEPA compiles and analyzes this information in the *National Water Quality Inventory Report to Congress*, the primary vehicle for reporting water quality conditions throughout the United States. To assess water quality, states and other jurisdictions compare their monitoring results to the water quality standards they have set for their waters.

Bioassessments help states, tribes, and other entities develop expectations for acceptable biological conditions through a technical process of establishing aquatic life goals, referred to as *aquatic life uses* (ALUs). Designated uses to support aquatic life can cover a broad range of biological conditions; not only do they protect intact communities in a waterbody, but they also can establish restoration goals for compromised ecosystems. Using several types, or tiers, of ALUs allows the allocation of limited resources to waterbodies in proportion to their need for protection.

Although the 305(b) report includes information on the nationwide status of aquatic life use attainment (i.e., state water quality standards), the results reported do not consistently present the information necessary to determine the ecological/biological condition of the Nation's water resources. As currently reported in 305(b) water quality assessments, aquatic life use attainment may be determined solely by chemical parameters and in comparison to chemical water quality criteria. However, since attainment of chemical water quality standards alone may not ensure a healthy biological condition, most states are working to integrate a greater amount of biological information in their aquatic life use attainment determinations (Yoder and Rankin 1995).

Under Section 303(d) of the CWA, a second reporting mechanism requires states, tribes, and territories to provide lists of all impaired waters. These lists are then used to prioritize restoration activities through the development of Total Maximum Daily Loads (TMDLs). TMDLs are calculations of the amount of a pollutant that a waterbody can receive and still meet water quality standards. Bioassessments and biocriteria play a critical role in enabling states, tribes, and territories to develop and implement protection and management strategies needed to fulfill these, and other, requirements of the Clean Water Act, including:

- ▶ determining impacts from nonpoint sources [i.e., Section 304(f) "(1) guidelines for identifying and evaluating the nature and extent of nonpoint sources of pollutants, and (2) processes, procedures, and methods to control pollution..."];
- ▶ developing lists of waters unable to support "balanced population(s) of shellfish, fish and wildlife..." [(304(l))];
- ▶ conducting assessments of lake trophic status and trends, [Sec. 314];
- ▶ listings of waters that cannot attain designated uses without nonpoint source controls, [Sec. 319];
- ▶ developing management plans and conducting monitoring in estuaries of national significance [Sec. 320];
- ▶ determining the impacts and efficacy of NPDES permit controls [Section 402];
- ▶ issuing permits for ocean discharges and monitoring ecological effects [Sec. 403(c) and 301(h)(3)]; and,
- ▶ determining acceptable sites for disposal of dredge and fill material [Sec. 404].

The 2001 Bioassessment Summary

During 1994-1995, EPA prepared an inventory of state bioassessment programs for streams and wadeable rivers, *Summary of State Biological Assessment Programs for Streams and Rivers* (USEPA 1996b). The purpose of the document was to determine how many states, and in what fashion, were using biological assessments and criteria in water management programs. EPA used the information from that report to evaluate state bioassessment/biocriteria capabilities and their needs for technical support.

During the second half of the 1990s as additional methods, guidance, and information on the use of biological assessments and criteria were issued by EPA, the Office of Water made it a national priority for state and tribal water quality standards programs to adopt biocriteria to better protect aquatic life in all waters where biological assessments methods were available (USEPA 1998b). In 1999, EPA's Office of Water declared the following goals and objectives for the biocriteria program:

- ▶ All states/tribes will use bioassessments/biocriteria to evaluate the health of aquatic life in all waterbodies.
- ▶ Bioassessment data will be used by all states/tribes to better define aquatic life uses.
- ▶ Numeric biocriteria will be adopted in all state/tribal water quality standards to protect aquatic life uses.
- ▶ Biocriteria/bioassessments will be used in ongoing regulatory programs.
- ▶ Biocriteria/bioassessments will be used to assess the effectiveness of water quality management efforts.
- ▶ Bioassessment data and biocriteria will be used to better communicate the health of the Nation's waters.

In the late 1990s, momentum to develop and adopt biocriteria grew, and pressures increased from the Total Maximum Daily Load (TMDL) Program to have well-established biocriteria in water quality standards to support listings of impaired waterbodies. The Office of Water and the Office of Environmental Information determined it would be valuable to re-assess the progress states were making in developing and adopting biological assessments and criteria into their water quality management programs. In 2001, Geoffrey Grubbs, Director of the Office of Water, Office of Science and Technology, stated that the key goal of the biocriteria program should be to accelerate the adoption of biocriteria in state and tribal water quality standards programs to better support regulatory programs. Therefore, in late 2001, the Office of Environmental Information and the Office of Water initiated this effort to update the 1994-95 survey information. This project was also supported by the Office of Wetlands, Oceans, and Watersheds and was coordinated through USEPA Regional Offices.

The goal of the 2001 update was to compile a comprehensive re-assessment of state use of bioassessments and biocriteria for protecting streams and wadeable rivers. The update also illustrates changes and improvements in bioassessment capabilities over the past six years, and serves as an important measure of program advancement and EPA's bioassessment technical transfer efforts. This documentation will enable USEPA to better focus its water quality standards and criteria development and implementation strategy for the next several years, target new program priorities, and assess the present technical support needs of states, tribes, territories, and interstate commissions. EPA will also use this documentation to prepare a summary report card of national progress in adopting biocriteria into water quality standards.

As you will see from this report, the use of biological assessment and criteria for managing the Nation's waterbodies has progressed significantly in the past six years and is equipping states, tribes, territories, interstate commissions, and EPA with a more effective set of monitoring and standards tools for determining and protecting the health of the Nation's waters.

1.2 Introduction to the Process

This project was coordinated by EPA's Office of Environmental Information in partnership with the Agency's Biocriteria Team, composed of members from the Office of Water (Office of Science & Technology, Office of Wetlands, Oceans, and Watersheds) and the Office of Environmental Information. The goal of the project was to obtain the current status of biological assessment programs and biocriteria development for streams and wadeable rivers. The project team also coordinated with EPA Regional Biocriteria Coordinators and Regional Indian Program Coordinators. Because identical information would be solicited from all 50 states, the District of Columbia, US territories, selected tribes, and selected interstate commissions, this project was covered under the Water Quality Standards Program Information Collection Request (ICR No. 0988.07) in compliance with the 1995 Paperwork Reduction Act.

In June 2001, the project team developed a "checklist" of 57 questions covering six different categories (Appendix C contains a blank copy of the checklist):

- contact information (including points of contact for biological programs for other waterbody types – nonwadeable rivers, lakes, reservoirs, estuaries/near coastal marine, and wetlands)
- programmatic elements
- ALU decision making process
- field and lab methods
- data analysis and interpretation
- information management

Throughout the autumn of 2001, email "packets" were distributed to over 75 points of contact in states, tribes, territories, and interstate commissions (provided by EPA Regional offices). These packets consisted of an introductory memo, the checklist, and relevant excerpts from each entity's water quality standards (where applicable). Recipients were asked to complete the checklist and review the standards excerpts for completeness and accuracy. As completed checklists were returned, members of the project team followed-up by phone and email with each entity to clarify, verify, and document information and to fill in gaps where necessary. Contacts from a total of 65 entities responded and provided the information included in this document.

As was done for the 1996 document, the project team created a template "program summary" used to translate and display the information gathered from each entity. The summary pages for each responding entity consist of a narrative program description, documentation and further information, as well as a three page fact sheet. Program summaries for all 65 entities are found in Chapter 3 (there are only 64 actual program summaries because Puerto Rico and the U.S. Virgin Islands are combined into one). The information in the program summaries was organized into several sections as shown below (Appendix D contains a blank program summary coded with the corresponding sections of the original checklist):

Contact Information

Program Description

Documentation and Further Information

Programmatic elements

- Uses of bioassessment within overall water quality program
- Applicable monitoring designs

Stream Miles

- Total miles
- Total perennial miles

- Total miles assessed for biology
 - fully supporting for 305(b)
 - partially/non-supporting for 305(b)
 - listed for 303(d)
 - number of sites sampled
 - number of miles assessed per site

Aquatic Life Use (ALU) Designations and Decision Making

- ALU designation basis
- ALU designations in water quality standards
- Narrative Biocriteria in WQS
- Numeric Biocriteria in WQS
- Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)
- Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU

Reference Site/Condition Development

- Number of reference sites
- Reference site determinations
- Reference site criteria
- Characterization of reference sites within a regional context
- Stream stratification within regional reference conditions
- Additional information

Field and Lab Methods

- Assemblages assessed (no. of samples/year, level of rigor)
- Benthos (sampling gear, habitat selection, subsample size, taxonomy)
- Fish (sampling gear, habitat selection, sample processing, subsample, taxonomy)
- Periphyton (sampling gear, habitat selection, sample processing, taxonomy)
- Habitat assessments
- Quality assurance program elements

Data Analysis and Interpretation

- Data analysis tools and methods
- Multimetric thresholds
 - transforming metrics into unitless scores
 - defining impairment in a multimetric index
- Multivariate thresholds
 - defining impairment in a multivariate index
- Evaluation of performance characteristics
- Biological data
 - Storage
 - Retrieval and analysis

In addition, selected relevant excerpts from state, tribal, territorial and interstate commission water quality standards excerpts were compiled into a separate chapter for inclusion in the document (see Chapter 4: Relevant Excerpts from Water Quality Standards and Biocriteria Language).

In April 2002, a preliminary draft of the document containing the Definition of Terms and Acronyms, Program Summaries, Water Quality Standards and Biocriteria Language, Literature Cited, and List of Contacts was distributed to the full Biocriteria Team for an editorial and technical review. Individual program summaries and water quality excerpts were distributed to the relevant EPA Regional contacts

and the point of contact for each responding entity for review and comment. During the summer of 2002, the project team compiled, organized, and incorporated the feedback received from all reviewers.

This document, *Summary of Biological Assessment Programs and Biocriteria Development for States, Tribes, Territories, and Interstate Commissions: Streams and Wadeable Rivers*, represents this project's final product. The document's value lies not only in the wealth of information it contains but also in the lessons learned from the process. In the near future, EPA hopes to initiate similar projects to assess the status of bioassessment and biocriteria programs for lakes, reservoirs, estuaries, and wetlands. The effectiveness and efficiency of those efforts will be enhanced by the development of this reference document.

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